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Laser-assisted uncovering of dental implants

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ABSTRACT

Introduction: Laser assisted uncovering of dental implants is one of the most interesting aspects of lasers utilization. Compared to conventional scalpel technique, this method provides less bleeding and pain and shorter healing period, leading to a better patient compliance. The objective of this study is to contribute a comprehensive review on laser assisted second-stage of implant surgery.

Materials and Methods: We searched Pubmed and Google Scholar databases using combined keyword search or medical subject headings. Eight articles from 2009 to 2019 were identified and assessed.

Results: Selected studies were categorized according to variables including amount of pain, need for anesthesia, soft tissue healing, temperature rise and quality of impressions. All the reviewed articles, measuring the amount of required anesthesia, agreed that laser-aided uncovering of implants needs significantly less anesthesia compared to conventional scalpel technique. Laser-assisted uncovering of their implants led to less pain. Ex-vivo studies measuring temperature rise, suggested that application of a non-contact 445nm diode laser reduces the temperature rise significantly. However, Er:YAG lasers proved to generate lower temperature rise. Diode lasers showed no significant amelioration of soft tissue healing whilst Er:YAG and Er,Cr:YSGG lasers revealed superior esthetic results and shorter healing period. Impressions can be taken 4-7 days after the laser-assisted surgery with a satisfactory quality.

Conclusion: Laser-assisted uncovering of implants can be selected as an alternative over the conventional scalpel technique. But, further studies are advisable.

Keywords: Laser assisted surgery; Dental implants; Uncovering; second-stage surgery.

Introduction

Parallel advancement of modern implant dentistry and laser dentistry has contributed to favorable results in laser-assisted implantology procedures, varying from placement to uncovering the implants and peri-implantitis treatment [1]. Uncovering of the submerged implants can be performed by plenty of techniques: the conventional scalpel technique, tissue punch, thermo-optically powered technology, electrosurgery and the laser-assisted technique [2,3]. Although the conventional technique is the most frequently used, it presents some drawbacks such as patient discomfort, bleeding, possibility of infections, postoperative pain and longer time needed for rehabilitation. Moreover, all these negative aspects inevitably influence the ergonomics of dental prac-

tice and lead to rise in costs consequently [4]. Beyond the myriad applications of lasers in dentistry, their utilization in the second phase of implant surgery is one of the most interesting functions of them as it provides less bleeding and postoperative pain, faster healing and improved patient compliance [5].

However, lasers have beneficial features over conventional scalpel technique. As laser-assisted surgery is not anticipated as a traumatic surgery, it reduces the patient discomfort, operative and postoperative pain [6,7]. Lasers empower less intra-operative bleeding which shortens the use of vasoconstrictors and anesthetics. Having antiseptic characteristics, lasers have a role in avoiding secondary postoperative infections. Moreover, bio-modulating effect of lasers improves healing process [8]. In addition, vaporization, coagulation and photo ablation of the irradiated tissues is accomplished by the aid of lasers [9]. Such as ablation or vaporization, hemostasis, biostimulation (photobiomodulation.

The interaction between lasers and tissues rests on irradiation parameters and on physical characteristics of the target tissue. Lasers which are principally utilized for soft tissue treatments are diode, carbon dioxide (CO_2) and neodymium: yttrium aluminum garnet (Nd:YAG) . Lasers such as erbium: YAG (Er:YAG) and erbium, chromium: yttrium-scandium-gallium-garnet (Er,Cr:YSGG) can be applied for both soft and hard tissues. Diode laser represents similar properties as the Nd:YAG laser. However, Nd:YAG laser results in temperature rise in deeper tissue layers whilst diode laser, despite generating a higher temperature than Nd:YAG, removes a thin layer of epithelium superficially without impacting the adjacent tissues like bone and periosteum [10].

Lasers, albeit representing plenty of beneficial features, depict some detriments which reduce clinicians to a dilemma as to utilize them or not. Relatively high cost of laser devices, need for additional education and possible thermal impact of lasers on the neighboring tissues are some of the drawbacks [2,11]. Er, Cr: YSGG lasers however, technical impediments such as lack of depth control and safe guidance of the laser beam besides controlling of it are currently the main factors that confine routine utilization of lasers [12]. The literature on the use of lasers in the second-stage implant surgery is still limited. To the best of our knowledge, no literature reviews regarding this specific subject has been published yet. In our article, we aimed to review the published literature regarding the effects of laser utilization in second-stage of implant surgery to clarify and classify the most effective parameters of lasers application in uncovering dental implants.

Materials and Methods

Relevant published studies were searched for in PubMed and Google Scholar from 2009 to January 2019 using the following keywords or, in case of PubMed database, medical subject headings: 'lasers', 'ucovering', 'second-phase', 'second-stage', 'implant', 'dental implants', 'surgery'. They were used alone or in combination using Boolean operators OR and AND. Randomized controlled trails (RCTs), case series and case reports involving human and non human subjects were searched for. Only English and full-text available articles were included [6]. RCTs and 2 case reports remained and were included in this article.

In this article, we focused on answering the following questions:

1. 'Does laser assisted technique of uncovering dental implants reduce pain and need for anesthesia?" This question was answered by 6 articles.

2. 'Does laser assisted second-stage of implant surgery ameliorates soft tissue healing ?" This question was answered by 3 articles.

3. 'Does the laser approach cause harmful temperature rise in dental implants?" This question was answered by 2 articles.

4. 'Does laser-assisted uncovering of implants influence the quality of impressions?" This question was answered by 3 articles.

Results

Features of each single study is summarized in Table 1.

3.1 Need for anesthesia

On the ground of a study carried out by Jawad et al. [13] laser-assisted uncovering of the implants proved to need significantly less anesthesia compared to the conventional scalpel technique. The laser-assisted uncovering procedure was tolerated by the patients of the study group through only topical anesthesia or a small amount of anesthetic infiltration (0.55ml) whilst all the

patients in the control group required infiltration of anesthesia with the mean volume of 1.37ml.

Similarly, El-Kholey [14] reported a significant difference regarding the need for anesthesia between patients whose implants were uncovered by 970nm diode laser and those managed with blade. Only one of the 15 patients in the laser group needed a small amount of anesthetic infiltration (0.4ml) while all patients of the blade group required an average volume of 0.9ml of anesthetic infiltration. In harmony with other studies, Kaur et al. [15] reported a statistically significant difference in the amount of needed local anesthesia during 810nm diode laser-assisted uncovering of the implants compared to the scalpel technique.

3.2 Pain reduction

Most of the studies reviewed in this article emphasized on the remarkable role of lasers in intra-operative and postoperative pain in second stage implant surgery, compared to conventional scalpel technique. Dominiak et al. [16] compared the amount of pain in 30 patients treated with 60 dental implants in second stage implant surgery. Left and right-mandible implants were uncovered by Er:YAG laser and conventional scalpel technique respectively. Pain experienced by the patients were evaluated by 11-point numeric pain scale (NRS-11) on which a rating of 0 means no pain, 1-3 stands for mild pain, 4–6 is moderate pain and 7–10 is severe pain. In the laser group, six of the patients reported no pain and none of the patients experienced a severe pain whereas in control group, 16 patients reported a severe pain and no painless treatment was experienced by any of the patients. Finally, the mean value of pain assessed on the NRS-11 for the Er:YAG laser and scalpel were 2.6 and 6, respectively.

In a comparative study performed by El-Kholey [10], 30 patients with 45 osseointegrated implants were divided into two groups for uncovering of their implants: 970nm diode laser group and surgical blade group. Subjective pain was evaluated with the aid of a 100-mm visual analogue scale (VAS) with 0 anchored by 'no pain' and 100 anchored by 'worst pain imaginable. No patient in either group suffered from serious pain as the mean value of experienced pain by the laser or blade group was 11.96 and 12.33, respectively. As a result, in contrast to the previously mentioned article, no significant difference in the amount of experienced pain was measured in this study.

3.3 Temperature rise

In an ex-vivo study implemented by Matys et al. [2], mandibles of 45 pigs were divided into three groups, aiming to evaluate rise in temperature regarding different diode laser wavelengths and contact/non-contact operation modes. Implants of group 1 were uncovered by a 445nm diode laser in non-contact mode. As a control group, implants of the group 2 were uncovered by the same wavelength as group 1 but in contact mode and second stage implant surgery was performed by 980nm diode laser in contact mode. Analysis of temperature rise in 60 seconds measured by a P1 thermocouple illustrated that application of a 445nm, non-contact diode laser reduces the temperature rise significantly. Authors suggested additional pulse intervals during laser irradiation with wavelength of 445nm when operating in contact mode. Additionally, surgical procedure time and incidence of carbonization were assessed in this study. When operating with a 445nm diode laser in contact mode, despite the shorter time needed for the uncovering procedures, it's more probable that carbonization occurs, as compared to group 1 and 3.

In another study, Fornaini et al. [3] designed an ex-vivo study as to measure thermal elevation induced by four different lasers on 4 pig jaws. Five implants on each pig jaws were placed for a total of 20 fixtures and were uncovered by diode (810nm), Nd:YAG (1064nm), Er:YAG (2940nm) and KTP (532nm). This study showed lower temperature increase for Er:YAG and higher for diode. Faster implant uncovering was obtained from KTP whereas diode laser required more time performing the same operation.

3.4 Soft tissue healing

Comparing diode laser (810nm) with conventional scalpel technique for uncovering dental implants in 20 patients, Kaur et al. [11] revealed no significant difference in healing index between laser and scalpel group. Gianfranco et al. [17] reported two cases of laser-assisted second-stage implant surgery, comparing the clinical effects of Er:YAG and diode laser. They found the Er:YAG laser implementing a very good healing process while diode laser caused a little bit discomfort and delay in healing process. As a result, authors suggested Er:YAG laser for operculisation of dental implants over diode laser. Arnabat et al. [18] performed the uncovering surgery of three patients with insufficient gingival attachment with the aid of Er,Cr:YSGG

laser. Due to inadequate keratinized gingiva, all the three implants were uncovered by raising a trapezoidal flap and apically repositioning and transpositioning of it to the buccal side. Compared to conventional scalpel technique, authors claimed remarkable reduction of healing time and superior esthetic results, possibly due to the obviation of sutures.

3.5 Impression taking

Comparing laser-assisted second stage of the implant surgery with the conventional scalpel technique, El-Kholey [10] claimed that impressions of the laser group could be taken after 7 days of the laser surgery. However, despite the satisfactory soft tissue healing of the scalpel group, edema at the gingival margins prolonged the needed time for impression taking to 12 days. Although impression taking could be implemented in a shorter period of time in laser-treated group, the difference between the two groups regarding this variable was not statically significant.

In contrast, Kaur et al. [11] reported a statistically significant difference between the two groups of their study, regarding the time for impression taking. Moreover, uncovering the implants by Er:Cr:YSGG laser in 3 patients, Arnabat et al. [15] could perform the impression taking only 4 days after the surgery, leading to a reduction in overall treatment time. Assessing the quality of taken impressions when uncovering implants with Er:YAG laser and scalpel, Dominiak et al. [16] designed a 3-point prosthetic impression scale (PIS) appraising the emergence profile of the implants. PIS-1,2 and 3 were representative of ideal, satisfactory and inadequate quality of impressions respectively. The impression of emergence profile in the laser group proved to be satisfactory for the preparation of prosthetic reconstructions.

Authors	*Number of implants*	*Laser wavelength*	*Type of study*	*Parameters evaluated*	*results*
Kaur et al.	*20*	*Diode 810nm*	*In-vivo*	*Need of anesthesia, duration of surgery, intraoperative bleeding, pain index,wound healing index*	*Diode laser (810nm) minimzed surgical trauma, reduced amount of anesthesia, improved visibility during surgery and eliminated postoperative discomfort. However, difference in time of healing was not statistically significant.*
Dominiak et al.	*45*	*Diode 445nm and 850 nm*	*Ex-vivo*	*Temperature rise*	*The application of the 445nm diode laser in non-contact mode reduced the temperature rise of the implants.*
Matys et al.	*60*	*Er:YAG*	*In-vivo*	*Pain and impression quality*	*The use of Er:YAG laser reduced pain and allowed minor surgical procedures to be carried out without anesthesia. The impression quality was satisfactory for the preparation of prosthetic reconstructions.*

Jawad et al.	50	Diode 970nm	In-vivo	Need for anesthesia, duration of surgery,intraoperative bleeding, subjective pain	Only 7.96% of patients needed local anesthesia uncovering their implants with diode laser. Whilst 100% of the patients whose implants uncovered by scalpel needed anesthesia.
Fornaini et al.	20	Diode 810nm Nd:YAG 1064 nm Er:YAG 2940nm KTP 532nm	Ex-vivo	Temperature rise	The mean increase in temperature (°C) at the peri-implant bone level was for diode laser, 14.08 °C; for Nd:YAG, 8.2 °C; for Er:YAG laser, 2.3 °C; and for KTP laser, 1.96 °C.
El-Kholey	45	Diode 970nm	In-vivo	Anesthesia, post operation pain, healing time, bleeding, duration of surgery	Reduced inflammation and time for taking impression, faster healing period and no need of anesthesia.
Arnabat-Domínguez et al.	3	Er,Cr:YSGG	In-vivo	Esthetics, pain, prosthetic rehabilitation time, temperature elevation	The results obtained were compared with those from other patients operated on by conventional scalpel. Er, Cr:YSGG laser minimized postoperative pain, and the time for prosthetic rehabilitation was also shortened. The esthetic results were far superior, and no complications were recorded.
Gianfranco	3	Er:YAG and diode	In-vivo	Cutting, soft tissue healing,hemostasis	Erbium laser proved to be faster in cutting than diod, and performed better in macroscopic cleaning of upmargins. very good healing of soft tissue in both of them.

Table 1. Summary of general characteristics of included studies.

Discussion

The key mechanism of surgical lasers is the photothermal interaction, a process by which the laser energy transforms to heat energy and then gets absorbed by tissues. In fact, local temperature rise is the ruling parameter of tissue-laser interaction which then, depending on the type of tissue and laser parameters, leads to reactions varying from coagulation, incision or vaporization [13]. Laser application improves the healing process of the soft tissue. The intraoral laser wounds tend to heal with minimal scar formation and pliable residual tissue which can often be left unsutured. This significant benefit of lasers is due to their precise control of depth, atraumatic nature and fewer myofibroblasts of laser wounds compared to scalpel wounds. As a result, it's evident that when the tissue is not harmed, there would be no tissue retraction which permits the sooner implementation of impression taking [13,19].

Decreased postoperative pain is a remarkable advantage of laser-assisted surgeries. Although the definite mechanism of pain reduction is still unknown, it can be attributed to decreased tissue trauma and alteration of neural transmission. Hypothetically, the protein coagulum on the wound surface of the lased tissue acts as a biological dressing and seals the sensory fibers [19].

Conclusion

With regard to the limitations of the current study, laser-assisted uncovering of dental implants can be selected as an alternative over the conventional scalpel technique due to less pain and need for anesthesia, faster soft tissue healing and satisfactory quality of impressions. However, due to the limited number of studies supporting the application of lasers in the second stage of implant surgery, further studies are advisable to confirm these promising results.

Conflict of Interest

There is no conflict of interest to declare.

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